

1. The first step is to identify the problem. This involves understanding the symptoms and the context in which they are occurring.

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Title of the Invention

RADIOACTIVE WASTE TREATMENT FACILITY

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RADIOACTIVE WASTE TREATMENT FACILITY

5 The present invention relates to a radioactive waste treatment facility for solidification of radioactive waste, which is generated from radioactive material handling facilities such as nuclear power plants, fuel reprocessing plants, and the like.

Generally, the radioactive waste is classified to various groups having different properties each other such as miscellaneous solid waste, concentrated liquid waste, spent resin, ashes, and others. Respective of the groups is handled with an appropriate treating method of injecting solidification or kneading solidification depending on its kind and properties.

25 The injecting solidification is a method, in which
the waste is contained in a drum first, and then, a
solidifying agent is injected into the drum from the top
of the drum for solidification. The injecting

5 The kneading solidification is a method, in which
the waste is solidified by kneading with a solidifying
agent. The kneading solidification method is applied to
powder, granular, or liquid waste such as concentrated
liquid waste and its dried powder, spent resin, ashes, and
10 the like. At this time, there are in-drum type and
out-drum type for the kneading method. The in-drum type
method is a method, in which, after charging the waste and
a solidifying agent together into a solidifying container
(or during charging), a kneading blade is inserted into
15 the charged materials to knead them. The out-drum type
method is a method, in which, after charging the waste and
a solidifying agent together into an exclusive kneading
container and kneading the charged materials by inserting
a kneading blade therein, the kneaded material is poured
20 into a solidifying container.

In order to solve the above problem, a radioactive

5 solidifying container to a designated location by the transferring means; charging a solidifying agent, additive water, and the radioactive waste into a kneading vessel of the kneader; agitating the charged material with kneading blade to form a kneaded material; and injecting
10 the kneaded material into the solidifying container by the kneaded material injecting means.

In accordance with the prior art described above, kneading the solidifying paste (solidifying agent + additive water) for kneading solidification, and kneading the kneaded material for kneading solidification are performed by a similar out-drum-mixer type kneader, in order to make it possible to perform injecting solidification and kneading solidification together by a single facility.

20 However, in accordance with the above prior art, the
following problems are still remained to be solved.

That is, the radioactive waste treating
(solidification) facility must be cleaned up after
completing a designated treatment. At that time, the
portions touched with the radioactive water are
contaminated with radioactive material, and washed water
of the portions become secondary radioactive waste and
another treating facility for the secondary radioactive

App
motivation

is known

SUMMARY OF THE INVENTION

One of the objects of the present invention is to
25 provide a radioactive waste treatment facility, which can
perform both the injecting solidification and the kneading
solidification together by a single facility, and makes
it possible to reduce the generating amount of the

(1) In order to achieve the above object, the radioactive waste treatment facility of the present invention comprises;

a solidifying agent kneading and injecting means for preparing a solidifying agent paste by kneading the solidifying agent and additive water, and injecting the solidifying agent paste into the solidifying container at a first location in the upstream of the transferring direction of the transferring means; and

In accordance with the radioactive waste treatment facility of the present invention composed as described previously, when the injecting solidification of radioactive miscellaneous solid waste is performed, a solidifying container, wherein the radioactive waste is charged previously, is transferred to the first location by the transferring means, and the solidifying paste is injected into the solidifying container by the solidifying agent kneading and injecting means. Therefore, as the solidifying paste is filled into the solidifying container

On the other hand, when the kneading solidification
of radioactive concentrated liquid waste, spent resin,
ashes, and others is performed, an empty solidifying
container is transferred to the first location by the
transferring means, and only the solidifying paste is
injected into the solidifying container by the solidifying
agent kneading and injecting means. Subsequently, the
solidifying container is transferred to the second
location; the radioactive waste is charged into the
solidifying container, wherein the solidifying paste is
filled previously, by the waste charging and kneading means
at the second location; and kneading is performed in the
solidifying container. Accordingly, a solidified waste
(homogeneous solidified waste), the solidifying paste and
the radioactive waste are mixed thoroughly, as same as the
one obtained by the normal injecting solidification can
be prepared.

In accordance with the composition described above, the injecting solidification and the kneading solidification can be performed by a single facility, and the solidifying agent kneading and injecting means can be made the out-drum type and the waste charging and kneading means can be made in-drum type.

At that time, the solidifying agent kneading and injecting means is used for kneading only the non-

(2) In accordance with the above methods described in (1), the solidifying agent kneading and injecting means desirably comprises;

a first kneading blade for agitating inside of the kneading vessel;

an injecting means for injecting the solidifying agent paste in the kneader for preparing the solidifying agent paste into the solidifying container.

an elevating means for elevating the solidifying
5 container, which has been transferred to the second
location by the transferring means, upward from the
transferring line of the transferring means; and

(4) In accordance with the above methods described in (1), the solidifying agent injecting and kneading means is desirably provided in an area separated from the waste charging and kneading means by separating walls.

These and other objects, features and advantages of
20 the present invention will be understood more clearly from
the following detailed description with reference to the
accompanying drawings, wherein,

FIG. 1 is a flow diagram for explaining the behavior at the kneading and solidifying operation of the solidifying agent kneading and injecting means and the waste charging and kneading means, which are provided in the radioactive waste solidification facility of the embodiment of the present invention,

FIG. 2 is a set of schematic illustrations indicating the transferring route of the solidifying container in the transferring mechanism, which is provided in the radioactive waste solidification facility of the
5 embodiment of the present invention,

FIG. 3 is a schematic illustration indicating a total outline of the compositions of the solidifying agent injecting and kneading mechanism and the waste charging and kneading mechanism, which are provided in the
10 radioactive waste solidification facility of the embodiment of the present invention,

FIG. 4 is a schematic illustration indicating the composition of the turn-table indicated in FIG. 2(a) and FIG. 2 (b), and

15 FIG. 5 is a flow diagram for indicating the behavior at the injecting and solidifying operation of the solidifying agent kneading and injecting means indicated in FIG. 3.

20 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, details of the embodiments of the present invention is explained referring to the figures 1 to 5.

The solidification facility of the present
25 embodiment is capable of solidifying four kinds of radioactive waste, i.e. the miscellaneous solid waste, spent resin, dried powder of concentrated liquid waste, and ashes, into a solidifying container (details will be

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The solidification facility comprises;
a solidifying agent injecting and kneading
mechanism 50 (details will be explained later) for
5 injecting and solidifying the miscellaneous solid waste
(hereinafter, called only as injecting solidification),
and for injecting the solidifying agent paste at kneading
and solidifying the spent resin, the dried powder of
concentrated liquid waste, and the ashes (hereinafter,
10 called only as kneading solidification);

a waste charging and kneading mechanism 60 (details will be explained later) for charging the radioactive waste and kneading at the kneading solidification;

and a transferring mechanism 5 (detail will be explained later) for transferring the solidifying container 4 (details will be explained later) selectively to the solidifying agent injecting and kneading mechanism or the waste charging and kneading mechanism depending on whether the operation is for the injecting solidification or the kneading solidification.

FIG. 2(a) and FIG. 2(b) are figures indicating the transferring route of the solidifying container 4 of the transferring mechanism 5 described above.

In accordance with FIG. 2(a) and FIG. 2(b), the transferring mechanism 5 is composed of, for instance, a plurality of rollers 50 arranged in a transferring direction (so-called roller conveyer, refer to FIG. 4); respective of the rollers is central-controlled by control

(refer to FIG. 2 (a)) from the sensor 80 is transmitted to the controller 70, corresponding control signals (not shown in the figure) are output to the main transferring route 5A from the controller 70, and the solidifying container is stopped once at the first position 5b. The solidifying agent injecting and kneading mechanism 50 is provided at upper position of the first position 5b. A total outline of the compositions of the solidifying agent injecting and kneading mechanism 50 is indicated in FIG. 3(a).

In accordance with FIG. 3(a), the solidifying agent injecting and kneading mechanism 50 comprises;

a solidifying agent silo 11;

a solidifying agent weighing apparatus 1 for weighing the solidifying agent, which is supplied from the solidifying agent silo 11 via the solidifying agent supply valve 16;

an additive water supply line 12;

an additive water weighing apparatus 2 for weighing the additive water, which is supplied from the additive water supply line 12 via the additive water supply valve 23;

a kneader 3 for solidifying agent, which kneads the solidifying agent supplied from the solidifying agent weighing apparatus 1 through the solidifying agent supply valve 17 and the additive water supplied from the additive water weighing apparatus 2 via the additive water supply valve 18 to prepare the solidifying agent paste, and

an injection valve 19 for injecting and filling the solidifying agent paste into the solidifying container 4.

The kneader 3 for solidifying agent is out-drum type apparatus comprising a kneading vessel 3a, whereto the solidifying agent and the additive water are supplied, and a kneading blade (agitating blade) 3b driven by a motor for agitating inside of the kneading vessel 3a.

Open-close operations of the waste supply valves 24a-24c and the waste supply valves 20a-20c are controlled by control signals from the controller 70 such as electric magnet valves, but details are omitted from the figures.

The whole solidifying agent injecting and kneading mechanism 50 composed as described above is installed in an area separated from the area where the other radioactive handling apparatus and facilities such as the waste charging and kneading mechanism 60 and others by, for instance, separating walls.

A sensor 81 (refer to FIG. 2) for detecting the solidifying container 4 when it is transferred there is provided at a second location 5c (at a position before a designated distance) in the sub-transferring route 5B (that is, at downstream side in the transferring direction from the first location) as indicated in FIG. 2 (a) and FIG. 2 (b). When the detecting signals of the sensor 81 'refer to FIG. 2) is transmitted to the controller 70, corresponding control signals are output from the controller 70 to the transferring mechanism sub-transferring route 5B, and the solidifying container 4 is

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stopped once at the second location 5c. The waste charging and kneading mechanism 60 is installed at the location upward the second location 5c. A whole schematic composition of the waste charging and kneading mechanism 5 60 is indicated in FIG. 3 (b).

In accordance with FIG. 3 (b), the waste charging and kneading mechanism 60 comprise;

waste supply lines 13a-13c for supplying radioactive waste,

10 waste weighing apparatus 6a-6c for weighing the radioactive waste supplied from the waste supply lines 13a-13c via the waste supply valves 24a-24c,

a waste supply line 21 for supplying the radioactive waste, which is weighed at respective of the waste weighing 15 apparatus 6a-6c, via the waste supply valves 20a-20c,

a solidifying container elevator 10 for elevating the solidifying container 4, which is transferred to the second location 5c, upwards from the transferring line 5C (refer to FIG. 1, explained later), and

20 a kneader 9 for kneading waste, which charges the radioactive waste supplied from the waste supply line 21 into the elevated solidifying container 4, and kneads the radioactive waste in the solidifying container 4.

The kneader 9 for kneading waste is so-called in-drum 25 type, which is provided with only kneading blade 9a (agitating blade) driven by motor for agitating inside of the solidifying container 4, and is composed so as to charge the radioactive waste supplied from the waste supply line

21 into the elevated solidifying container 4, and to knead the radioactive waste in the solidifying container 4 by dipping the kneading blade 9a therein (refer to FIG. 1, explained later).

5 The solidifying container elevator 10 comprises a base 10a; an extendable arm mechanism 10b provided with, for instance, a hydraulic cylinder; and a solidifying container platform 10c located at the second location 5c in the sub-transferring route 5C; and the solidifying
10 container platform 10c can be elevated or lowered depending on extending-shrinking motion of the extendable arm mechanism 10b corresponding to extending-shrinking motion of the hydraulic cylinder.

 The number of the waste supply lines 13a-13c, waste
15 supply valves 24a-24c, waste weighing apparatus 6a-6c, and the waste supply valves 20a-20c to be provided are decided depending on the number of kinds of waste to be kneaded and solidified. For instance, spent resin is supplied through the waste supply line 13a, dried powder of
20 concentrated liquid waste is supplied through the waste supply line 13b, and ashes is supplied through the waste supply line 13c.

 The solidifying agent supply valve 16, the solidifying agent supply valve 17, the additive water
25 supply valve 23, and the additive water supply valve 18 are controlled their open-close motion 8 (for instance electric magnet valve) by the control signals from the controller 70, but details are omitted in the figure.

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FIG. 4 is a schematic illustration indicating the composition of the turn-table 5a1 indicated in FIG. 2(a) and FIG. 2 (b). The turn-table 5a is not operated for a special motion when the solidifying container 4 moves in a straight direction on the main transferring route 5A (that is, when it moves as route 5A1 \rightarrow turn-table 5a1 \rightarrow route 5A). However, when the moving direction must be changed (that is, when it moves as route 5A1 \rightarrow turn-table 5a1 \rightarrow route 5C), the turn-table is operated as follows.

Then, a control signal is output from the controller

After completing the rotation, a driving control
5 signal (not shown in the figure) is output from the
controller 70 to the driving roller 50 on the turn-table
5a1, and the transfer is resumed by transferring the
solidifying container 4 to the sub-transferring route 5C
from the turn-table 5a1.

As explained above, the transferring mechanism 5
composes the transferring means for transferring the
solidifying container as claimed in respective of the
15 claims.

The solidifying agent injecting and kneading means for injecting the solidifying agent paste into the solidifying container at the first location in the upstream side in the transferring direction of the transferring means comprises; solidifying agent silo 11, solidifying agent supply valve 16, solidifying agent weighing apparatus 1, solidifying agent supply valve 17, additive water supply valve 23, additive water weighing apparatus

2, additive water supply valve 18, kneader 3 for solidifying agent, and injecting valve 19.

An elevating means for elevating the solidifying container, which is transferred to the second location by the transferring means, upwards from the transferring line of the transferring means comprises the solidifying container elevator 10, and the second kneading blade comprises the kneading blade 9a of the kneader 9 for waste.

The waste charging and kneading means, which is capable of charging radioactive waste into the solidifying container at the second location in the downstream of the first location in the transferring direction of the transferring means and of kneading the radioactive waste in the solidifying container, comprises waste supply lines 13a-13c, waste supply valves 24a-24c, waste weighing apparatus 6a-6c, waste supply valves 20a-20c, waste supply lines 21, and kneader 9 for waste.

The separating wall is composed of partition walls 27.

Operation of the radioactive solidification facility composed as explained above of the present embodiment is explained hereinafter.

In accordance with the solidification facility, an instruction for switching an injecting and solidifying mode for performing the injection and solidification, and a kneading and solidifying mode for performing kneading and solidification is input at the control room, and corresponding signal is output to the controller 70. Then,

the controller 70 controls automatically respective of the apparatus so as to operate appropriately corresponding to respective of the wastes.

(1) Injection and solidification

5 When the injecting and solidifying mode is selected in the control room, the solidifying container 4 is transferred by the route indicated in FIG. 2 (a), and the solidification treatment is performed. The process is explained referring to FIG. 2 (a) and FIG. 5.

10 In accordance with FIG. 2(a), the solidifying container 4, wherein miscellaneous solid waste has been charged by operators previously, is loaded on the main transferring route 5A, and transferred to the first location 5b by the transferring mechanism 5 and stopped
15 once.

In a condition that the solidifying container 4 is stopped at the first location 5b, an adequate amount of solidifying agent for injection and solidification of the miscellaneous solid waste is weighed by the solidifying
20 agent weighing apparatus 1, and injected into the kneader 3 for solidifying agent. Subsequently, an adequate amount of additive water for injection and solidification of the miscellaneous solid waste is weighed by the additive water weighing apparatus 2, and injected into the kneader 3 for
25 solidifying agent. The solidifying agent and the additive water injected into the kneader 3 for solidifying agent is kneaded under a designated condition to be the solidifying agent paste, and injected into the solidifying

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The solidified waste of the miscellaneous solid waste obtained as above is transferred as it is on the main transferring route 5A by the transferring mechanism 5, and stored in a storage place (not shown in the figure).

When the kneading and solidifying mode is selected in the control room, the solidifying container 4 is transferred by the route indicated in FIG. 2 (b), and the solidification treatment is performed. The process is explained referring to FIG. 2 (b) and FIG. 1.

In a condition that the solidifying container 4 is
25 stopped at the first location 5b, an adequate amount of
solidifying agent for treating the waste (hereinafter,
called selected waste) selected at the control room from
spent resin, dried powder of concentrated liquid waste,

and ashes is weighed by the solidifying agent weighing apparatus 1, and injected into the kneader 3 for solidifying agent, as indicated in FIG. 1. Subsequently, an adequate amount of additive water for solidification of the selected waste is weighed by the additive water weighing apparatus 2, and injected into the kneader 3 for solidifying agent. The solidifying agent and the additive water injected into the kneader 3 for solidifying agent is kneaded under a designated condition to be the solidifying agent paste having an adequate water-cement ratio and weight for kneading and solidification of the selected waste, and injected into the solidifying container 4.

The solidifying container 4 injected by the solidifying agent paste is transferred on the main transferring route 5A by the transferring mechanism 5, and changed its transferring direction by the turn-table 5a2 to the sub-transferring route 5C. The solidifying container 4 is transferred further to the second location 5c on the sub-transferring route 5C, and stopped there once.

Under the condition that the solidifying container 4 is stopped at the second location 5c, the solidifying container 4 is elevated by the solidifying container elevator 10, which is installed under the kneader 9 for waste, until the upper periphery 4a (an opening portion) of the solidifying container 4 is touched with the lid portion 9b of the kneader 9 for waste. In this condition,

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under agitation and kneading by driving the kneading blade 9a, a designated amount of selected waste is charged into the solidifying container 4 from the waste weighing apparatus 6a-6c corresponding to the selected waste.

5 Accordingly, a solidified waste, wherein the solidifying agent paste and the selected waste are mixed thoroughly, as same as the solidified waste (homogeneous solidified waste) obtained by the normal kneading and solidification can be prepared.

10 At this time, the kneading is continued for a designated time after completion of charging the total amount of the selected waste. After completion of the kneading, the solidifying container 4 is lowered to the level of the transferring mechanism 5 again by the
15 solidifying container elevator 10. During the above operation, the upper periphery 4a of the solidifying container 4 and the lower plane of the lid portion 9b of the kneader for waste is contacted tightly in order to prevent the kneaded material in the solidifying container
20 4 from splashing out.

The homogeneous solidified waste obtained as described above is transferred on the sub-transferring route 5C again, changed its transferring direction by the turn-table 5a3 on the main transferring route 5A, and
25 transferred on the main transferring route 5A to a storage place which is not shown in the figure.

In accordance with the solidifying facility of the present embodiment, which is composed as described above,

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Furthermore, the solidifying agent injecting and kneading mechanism 50 can be made out-drum type, and the waste charging and kneading mechanism 60 can be made in-drum type.

Generally, the solidifying agent paste prepared by

Generally, the solidifying agent paste prepared by

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5 kneading the solidifying agent and the additive water has a low viscosity, but the adding the waste and kneading increases the viscosity. In accordance with the out-drum type (kneading vessel + kneading blade) kneading and solidification, the increased viscosity of the kneading material generates a possibility to choke the outlet of the kneading vessel when the kneaded material is discharged.

10 In accordance with the present embodiment, an advantage is realized that the choke described above can be prevented, because kneading the solidifying agent paste having a low viscosity is performed by the out-drum type solidifying agent injecting and kneading mechanism 50, and kneading the radioactive waste is performed by the in-drum type waste charging and kneading mechanism 60.

15 In accordance with the present embodiment, changing the transferring direction of the solidifying container 4 is performed using the turn-table 5a by turning the turn-table 5a by 90 degrees under a condition that the solidifying container is loaded on the turn-table 5a, but methods of changing the transferring direction is not restricted to the above method, and other method is usable.

20 That is, when the solidifying container 4 is stopped on the turn-table 5a, for instance, the solidifying container 4 is transferred to the sub-transferring route 5C by hanging the solidifying container 4 with a hanger which is provided particularly, by pushing the solidifying container 4 to the direction toward the sub-transferring

route 5C with a pusher which is provided particularly, or other transferring mechanism, which has a function to transfer the solidifying container 4 to the sub-transferring route 5C, inserted beneath driving rollers 5 50 of the turn-table 5a to operate between the rollers 50.

In accordance with the present invention, the injection and solidification operation and kneading and solidification operation can be performed selectively by a single facility, and generating amount of the radioactive 10 secondary waste can be decreased.

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